Figure 1, code wheels 38 and micro controller 40 are shown in Figure 3, switching means 34 is shown in Figure 2, drain 53 is added in Figure 3, and means 35 is shown in Figure 3. With respect to the positions A-C of bolt 21 and the U-shaped key 22, the bolt 21 varies its positions from power to ground within the circuit by raising or lower the bolt 21 via rotation of the U-shaped key 22, as is set forth in the Specification, for example, at page 3, lines 21-24 and again at page 5, lines 5-18. Applicants submit that one reasonably skilled in the art would know and understand how the rotational movement of a U-shape key driving a bolt would be directable between a variety of positions for controlling a circuit. Reconsideration and withdrawal of the objections to the drawings are thus respectfully requested.

In paragraph 4 of the Office Action, the Specification was objected to and the filing of a Substitute Specification was recommended. Filed herewith is a Substitute Specification, including a marked-up copy of the originally filed Specification. The Substitute Specification includes all of the changes shown in the marked-up copy. No new matter is introduced. Accordingly, withdrawal of the objection to the Specification is respectfully requested.

In paragraph 6 of the Office Action, claims 20 and 21 are rejected under 35 U.S.C. §112, first paragraph. The rejection is respectfully traversed.

The code wheels described are part of a programming means setting a time interval that controls whether power is supplied to the primary resistor. The code wheel programming means is therefore a circuit switch control based on a time interval, similar in concept to a programmable timer controlling a standard household lamp. Applicants maintain that the description is well within the ability of one skilled in the art to make and use a code wheel in the context of a detonator primer as described and claimed. Accordingly, withdrawal of the 35 U.S.C. §112, first paragraph, rejection of claim 20 and 21 is respectfully requested.

In paragraph 7 of the Office Action, claims 16-29 are rejected under 35 U.S.C. §112, second paragraph. Claim 16 has been amended in accordance with the suggestion of the Office Action. Accordingly, withdrawal of the 35 U.S.C. §112, second paragraph, rejection of claims 16-29 is respectfully requested.

In paragraph 9 of the Office Action, claims 14-17 are rejected under 35 U.S.C. §102(b) as anticipated by Hedberg et al. The rejection is respectfully traversed.

To maintain a 35 U.S.C. §102 rejection a reference must teach each and every element of the claimed invention. Hedberg et al. do not do so.

Applicants invention comprises a priming device for firing a detonator upon expiration of a designated time interval, the priming device having an electrical power supply that provides, through a resistive circuit, power of a sufficient first intensity to actuate a timing circuit. The first intensity not being sufficient to actuate the detonator firing element of the primer. A second intensity generated by the power supply actuates the detonator firing element of the primer after the designated time interval has expired. The second intensity is achieved via the power generation supply means connected to the time circuit. The power generating means includes a capacitor, a switch means, and a controlling means, within the context of a resistive circuit whereby the controlling means controls the charging of the capacitor for a designated charging time by controlling the switching means closing the circuit to the capacitor. Thereafter, the capacitor is discharged causing the detonator firing element to act upon the primer. None of the applied art teach disclose or suggest the combination of features claimed.

Hedberg et al. (U.S. Patent No. 4,145,970) disclose a detonator cap 1 including a single explosive charge 2 connected to a firing means 3 having an electric filament 4 therein. The electric filament 4 is connected to a capacitor 5 controlled by a first control means 8 and

a second control means 14 based upon current or induction signals (column 3, lines 21-31). In Hedberg et al., in the case of environmental electromagnetic pulses, ignition of the detonator can occur as there is no resistor or filter to limit the power intensity from those pulses (Figure 2). Thus, nothing in Hedberg et al. teach, disclose or suggest that a first power intensity is insufficient to ignite the detonator as in the claimed invention. Accordingly, the structure and function of Hedberg et al. is different than that claimed. Therefore, withdrawal of the 35 U.S.C. §102(b) rejection of claims 14-17 is respectfully requested.

In paragraph 12 of the Office Action claims 14-19, 22, 25 and 26 are rejected under 35 U.S.C. §102(e) as anticipated by Beukes et al. (U.S. Patent No. 6,085,659). The rejection is respectfully traversed.

Applicants invention is set forth in detail above.

Buekes et al. disclose a detonator 10 using an electronic explosive initiating device 12 including a circuit 14 electrically linked via a bonding wire 40 to a substrate 34 having a circuit pattern including a first capacitor C_1 that stores energy to operate the circuit via a second capacitor C_2, a first control unit 70, and a second control unit 72 (column 4, line 51-63). Contrary to the Examiners assertions that only the larger voltage from the capacitor will ignite a firing element 16 (citing the Abstract), it is not a voltage which ignites the detonator but is an energy equal to $\frac{CV^2}{2}$ in the case of a capacitor. It is clear however, that an increase in the percentage of voltage increases the energy more than the same percentage of the capacity. However, it is very dangerous to have several devices using different voltages as it can lead to energy transference and to the ignition of the detonator. Such is distinctly different from the claimed invention wherein a unique low voltage (6V) for the supply of the module and for the ignition of the detonator is provided. Thus, as set forth with respect to Hedberg et al. earlier, Beukes et al. fail to teach, disclose or suggest the combination of

features claimed. Accordingly, withdrawal of the 35 U.S.C. §102(e) rejection of claims 14-19, 22, 25 and 26 is respectfully requested.

In paragraph 16 claims 23 and 24 are rejected under 35 U.S.C. §103(a) as unpatentable over Beukes et al. in view of Jarrott et al. (U.S. Patent No. 4,632,031). The rejection is respectfully traversed.

Applicants invention is set forth in detail above.

Beukes et al. is set forth in detail above as well.

Jarrott et al. fail to overcome the deficiencies of Beukes et al. Accordingly, withdrawal of the 35 U.S.C. §103(a) rejection of claims 23 and 24 on the basis of Beukes et al. in view of Jarrott et al. is respectfully requested.

In paragraph 18, of the Office Action claim 27 is rejected under 35 U.S.C. §103(a) as unpatentable over Beukes et al. The rejection is respectfully traversed.

Applicants invention is set forth in detail above.

Beukes et al. is discussed in detail above. Beukes et al. fail to teach, disclose or suggest the combination of features claimed for the reasons set forth above. Accordingly, withdrawal of the 35 U.S.C. §103(a) rejection of claim 27 is respectfully requested.

In paragraph 20 of the Office Action claims 28 and 29 are rejected under 35 U.S.C. §103(a) as unpatentable over Beukes et al. in view of Powell (U.S. Patent No. 5,877,696). The rejection is respectfully traversed.

Applicants invention is set forth in detail above.

Beukes et al. is set forth in detail above as well.

Powell fails to overcome the deficiencies with respect to Beukes et al. Accordingly, withdrawal of the 35 U.S.C. §103(a) rejection of claims 28 and 29 on the basis of Beukes et al. in view of Powell is respectfully requested.

Reconsideration of the application is respectfully requested. It is submitted that claims 14-29, in view the remarks made herein, patentably distinguish themselves over the art applied and pose no 35 U.S.C. §112 issue. Accordingly, allowance of claims 14-29 is respectfully requested.

Should the Examiner believe anything further is desirable to place the application in even better form for allowance, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

Respectfully submitted,

William P. Berridge
Registration No. 30,024

Dermott J. Cooke
Registration No. 41,685

WPB:DJC\sld

Attachments:
Appendix
Substitute Specification
Marked-up copy of Specification
Request for Approval of Drawing Corrections

Date: April 2, 2001

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

APPENDIX

Changes to Claims:

The following are marked-up versions of the amended claims:

14. A priming device for a detonator, comprising:

timing means for timing the action of a firing element of a primer; and

an electrical power supply that provides a first power intensity to the timing means and power generating means, the power generating means capable of generating, through a resistive circuit, a second power intensity sufficient to actuate the firing element upon expiration of a timing interval as determined by the timing means, ~~and~~ the first power intensity from the power supply ~~is~~ not being sufficient to actuate the firing element.

16. A priming device for a detonator, comprising:

an electrical power supply means for timing the action of a firing element of a primer; and

power generating means ~~capable of~~ for generating, through a resistive circuit, a ~~power~~ current intensity sufficient to actuate the firing element upon expiration of a timing interval, ~~an intensity sufficient to actuate the firing element,~~ the power generating means comprising a capacitor, switching means, and controlling means for controlling the switching means by allowing the capacitor to be charged for a charging time and then discharged, the discharge causing the firing element to act on the primer.

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PROGRAMMABLY TIMABLE PRIMING DEVICE

Background of the Invention

1. Field of Invention

The present invention relates to the field of electrical firing mechanisms, and more particularly that of priming devices of an ignition detonator for miniature bombs, projectiles, missiles, and mines, having an electrical power supply and means for timing the action of a firing element of a primer.

2. Description of Related Art.

It is known to use priming devices having means for timing the action of a firing element of the primer.

~~Said~~ The timing means are generally electronic, and failure thereof can result in premature action of the element on the primer, and thus in explosion of the weapon with which they are associated. It is self-evident that ~~said~~ the explosion can have serious consequences for the user or users.

To avoid this problem, French Patent ~~2670576~~ No. 2670576 describes a neutralization device ~~(1)~~ for weapons, having a housing, a pyrotechnic chain deactivated by mechanical safety means (in this instance a clock), and a timer which can be controlled by transmission means.

A device of this kind has a drawback, however, when it is desired to prime several neutralization devices simultaneously. The reason is that each of the timers must be programmed while taking into account the time used to program the previous ones. Such programming cannot therefore be other than imprecise, and leads to successive explosions because it does not allow for multiple simultaneous firings.

One of the purposes of the invention is to remedy these drawbacks by proposing a reliable electronic or electromechanical priming device, the timing system of which can be programmed simultaneously for multiple priming devices with the aim of achieving perfect synergy.

Summary of the Invention

According to the invention, a priming device of a detonator therefore has an electrical power supply providing a first intensity to a circuit having means for timing the action of a

firing element of a primer and to means capable of generating, upon expiration of the timing interval, a second intensity sufficient to actuate the element, the first intensity emerging from the power supply not being sufficient.

According to a particular feature, the means are constituted by a capacitor, switching means, and means for controlling the switching means allowing the capacitor to be charged for a charging time (Tp2), then discharged, the discharge causing the element to act on the primer.

According to another variant of the invention which allows numerous associated devices to be added, a priming device of a detonator has an electrical power supply means for timing the action of a firing element of a primer, and means capable of generating, upon expiration of the timing interval, an intensity sufficient to actuate the element, the latter means having a capacitor, switching means, and means for controlling the switching means allowing said capacitor to be charged for a charging time, then discharged, the discharge causing the element to act on the primer, the control means comprising a microcontroller.

In addition, the switching means can be constituted, for example, by transistors.

In order to improve the operating flexibility of the device, it is preferable for the timing means to have means for programming the timing interval; the means can be entirely or partially integrated into the priming device. The means may comprise, for example, code wheels or a microcomputer.

According to a particular feature, the means comprises external means having an electrical power supply, a microcontroller, a display, two programming switches, and transfer means comprising phototransistors.

According to another feature capable of preventing neutralization of the weapon by an unauthorized person, or of deliberately anticipating firing, a priming device according to the invention has booby-trap means which may include a circuit comprising switching means,

the opening of which causes the primer to fire.

Lastly, another object of the invention is a method for safing a priming device of a detonator, of the type having an electrical power supply and means for timing the action of a firing element of the primer, wherein the method comprises, upon expiration of the timing interval, charging a capacitor and then discharging it to cause firing.

Brief Description of the Drawings.

Other advantages and features of the present invention will be apparent from the description of several variant embodiments with reference to the attached drawings, in which:

Figure 1 depicts a simplified general diagram of the device according to the invention;

Figure 2 shows a diagram of the principal programming means;

Figure 3 depicts a variant embodiment of the invention;

Figure 4 shows a diagram of the external programming means according to a particular variant embodiment of the invention; and

Figure 5 shows a particular embodiment of the invention.

Description of the Preferred Embodiments.

Figure 1 shows a diagram of the principal constituent means of a firing device of a primer of a detonator according to the invention. The said means are of the type having a housing within which are arranged electrical power supply means 10 for a circuit comprising principally a firing resistor 12 of primer 13, circuit closing means 20, and means 30 for timing firing after the circuit is closed.

Power supply means 10 comprises two lithium batteries supplying a voltage of 6 V.

In this variant embodiment, circuit closing means 20 comprises a mechanical bolt 21 having two positions, A and C, which is connected to a U-shaped key 22 placed in a constriction on the exterior of the housing, rotation of which allows the bolt to be placed in the desired position.

As shown in Figure 2, firing timing means 30 have means 32 for programming a timing interval, means 34 for switching the circuit which supplies power to priming resistor

12, and a capacitor 36 supplying an intensity I2 as it discharges, intensity I1 of the charging current of ~~said~~ the capacitor being insufficient to cause firing of the primer.

In this first variant embodiment, programming means 32 ~~are constituted by~~ comprises code wheels 38 and a microcontroller 40. ~~Said~~ The code wheels are luminescent, allowing programming both at night and during the day.

Microcontroller 40 controls the opening and/or closing of switching means 34.

As shown in Figure 3, ~~said~~ the switching means 34 have first means 41 ~~constituted by~~ including an electromechanical safety device 41 comprising a mechanical clock, associated with a mechanical changeover switch which is normally in the open position and which closes the circuit upon expiration of a predetermined operating interval of ~~said~~ the clock.

They have second means ~~constituted by~~ comprising a transistor 50 whose source is connected to power supply 10, its gate to microcontroller 40, and its drain to the input of the changeover switch of electromechanical assembly 41, and a transistor 55 whose source is connected to priming resistor 12, its gate to microcontroller 40, and its drain to the output of the changeover switch.

Third means ~~are constituted by~~ comprises a timed-closure switch 65 arranged between electrical power supply 10 and microcontroller 40.

In addition, drain 53 of transistor 50 is connected to a short-circuit transistor 60 which is in turn connected to microcontroller 40 and to ground.

Moreover, resistors 70, 71, 72 limiting the current intensity are located in the circuit upstream from the electromechanical means and between the microcontroller and transistor 55, so that in the event the transistors and the electromechanical means fail, the current passing through priming resistor 12 is of an intensity insufficient to cause priming of the detonator.

Furthermore, signaling means 81 and 80 are arranged respectively downstream from timed-closure switch 65 and in parallel with priming resistor 12.

Lastly, means 35 comprising elements 10 and 36 are capable of generating, upon expiration of the timing interval, an intensity I2 sufficient to actuate priming resistor 12, power supply 10 providing an intensity I1 capable of charging the capacitor and the latter supplying an intensity I2 when it discharges.

With this embodiment, in which the programming means comprises code wheels 38, when mechanical bolt 21 is in position A all the electronic means are grounded; while in position C, all the electronic means are powered, but capacitor 36 is not in any case connected to the power supply circuit until after a safety delay time generated by electromechanical safety device 41.

In a second variant embodiment, the programming means comprises an external programming device 100 and by information transfer means, by direct contact such as an RS232 connector, or of the transmission/reception type, for example using phototransistors. In this instance the circuit closing means are preferably comprises a mechanical bolt 21 having three positions, A, B, and C: a position A in which all the electronic means are grounded; a position B in which capacitor 36 is grounded and power is supplied to the other electronic means; and a position C which follows position B and in which capacitor 36 is connected to the circuit after a safety delay time generated by electromechanical safety device 41.

External device 100 may comprise a microcomputer of the portable type into which a program is loaded, said program allowing the user to indicate, in particular, the firing time either in the form of a date, which then requires entry of the programming date if it does not already exist in the microcomputer, or in the form of a delay interval. After the user has confirmed the programming, the data are transferred via an RS232 connector to one or more priming devices simultaneously.

The external device 100 can also include an assembly comprising an electrical power supply 110, a microcontroller 140, a display 145, two programming switches

146, 147, and a run/stop switch 112; and the transfer means comprise phototransistors 148, 149 associated with phototransistors arranged in the housing.

In this case, selection of parameters is accomplished via a preprogrammed drop-down menu. Data are displayed in blocks, and all the parameters associated with a block appear alongside one another, so that an overall view of the progress of each one is retained while programming the block.

There are four blocks, as follows:

DATE: corresponding to the programming date

DIRECT: the timing interval prior to priming of the detonator

CALENDAR: the date on which priming is to occur

TRANSMIT: validation of this block causes the programmed data to be transferred to the igniter.

As regards the two switches 146, 147, the function of one is to validate the data entry that is displayed and to display the first datum of the next parameter, which can be in the same block or the first one of the next block.

A booby-trap module 200, of the contact-opening type, is also added to the means described in the aforementioned first variant embodiment. The module comprises a closed circuit, powered by power supply means described above, and comprises a certain number of contactors whose method of opening depends on the type of booby-trapping, which are connected to microcontroller 40. As an example, the contactors can be opened by remote control, or can be inertial, or can more simply be a tripwire resting on the ground in the vicinity of the igniter.

A device according to the invention, programming of which is accomplished by way of an external device 100, operates as follows:

The batteries are placed in the housing before it is used, and mechanical bolt 21 is in position A, means 20 and 30 thus not being supplied with electrical power.

The user then disengages key 22 from the constriction on the housing, then proceeds to turn the latter to position B in which capacitor 36 is grounded and power is applied to the other electronic means. The receiving circuit has two phototransistors 48, 49 located as close as possible to a portion of the housing which is transparent to the radiation emitted by phototransistors 148, 149 of device 100. The housing also has a notch which allows the respective phototransistors of programming means 100 and of the firing means to be positioned precisely opposite one another.

Once the run/stop switch has been closed, the microcontroller of assembly 100 causes a menu to drop down, displayed block by block on display 145, the transition to the next parameter of one block or to the next block being accomplished by actuating one of programming switches 146, 147, the other serving to validate the parameters and transmit them to the firing device.

The menu can, for example, have two blocks, one concerning the desired timing interval D1 in a day/hour/minute/second format, i.e. four parameters, and the other relating to the validation of the parameters and transmission of said parameters via phototransistors 148, 149, 48, 49.

When all the parameters have been validated, validation of the TRANSMIT block causes the parameters to be transferred from device 100 to the priming device. In return, microcontroller 40 sends back a copy of the parameters which is received by device 100, which verifies that they conform to those sent out previously, and issues a confirmation message releasing the transmission.

It is evident that when the priming time is selected in calendar mode, it is possible to transmit the same parameters, successively or simultaneously, to a plurality of priming devices, and thus to synchronize all the priming events.

The use of a microcomputer makes this synchronization operation even easier. All that is necessary is to connect the microcomputer to each of the RS232 connectors of the

various priming devices being synchronized, and then to transfer the parameters simultaneously to all the devices.

The firing means are then placed on a suitable explosive device. In the case of a mine, it can be placed on the target to be destroyed, by the user, who then proceeds to turn key 22 to position C and then withdraws it from the housing to prevent any access by an unauthorized person to bolt 21.

In this position, the countdown of the timing interval D1, which began when the transmission was released, continues, while the mechanical timing clock of the electromechanical safety means is triggered. Upon expiration of a preprogrammed operating time Tp1 of the clock, it causes mechanical changeover switch 41 to trip, and thus causes closure of the portion of the circuit located between transistor 50 and capacitor 36.

Thus, in all cases in which timing interval D1 programmed by the user is less than preprogrammed time Tp1, or in cases where microcontroller 40 or transistors 50, 55, 60 fail, firing cannot in any case take place until after the time Tp1 has elapsed.

After value D1 has counted down, microcontroller 40 deactivates short-circuit transistor 60 and activates transistor 50 which then becomes conductive. Capacitor 36 then charges, and after a preprogrammed time Tp2, called the capacitor charge time, has elapsed, microcontroller 40 activates transistor 55 which becomes conductive, thus allowing capacitor 36 to discharge through the transistor 55 and through priming resistor 12, the intensity I2 passing through the latter being sufficient to cause priming of the detonator.

Allowing the capacitor to charge only upon expiration of a timing period increases the reliability of the device, since no capacitor leakage current is present during that period.

Be it also noted that for safety reasons, it is preferable for capacitor charging time Tp2 to be long as compared with its discharge time. Any malfunctions which would be expressed as simultaneous actuations of all the transducers (such as EMP or nuclear effects) would thus have no consequences.

In addition, the process of charging the capacitor can of itself meet a need for nondegradable safety. The safety time is then just shorter than the time which results in a significant capacitor charge, i.e. one capable of causing firing of the primer when it discharges. It can be adjusted via the charging current. In this case an electromechanical safety device 41 is not necessary, whether capacitor charging is performed at power-up or before firing. In applications in which the safety time is very long and/or when the booby-trap module is used, however, utilization of electromechanical safety device 41 is required.

Especially when programming means 32 comprises coding wheels 38 and microcontroller 40, timed-closure switch 65 can be inserted into the circuit so as to generate an additional safety delay Tp3 before any firing when the user turns the key from position A to position C. In this variant embodiment, this delay is an operational safety delay: during this delay time, which is an integral part of interval D1, all the switching functions of transistors 50, 60, 55 of microcontroller 40 are inhibited.

Concurrently, the mechanical timing clock of electromagnetic safety means 41 is triggered. Upon expiration of a preprogrammed operating interval Tp1 for the clock, it causes the mechanical changeover switch associated with it to trip, thus causing closure of the portion of the circuit located between transistor 50 and capacitor 36.

Switch 65 and the clock thus comprise two simultaneously triggered safety elements of different types: one electrical, which acts on microcontroller 40; and the other mechanical, which acts on capacitor 36, such that priming of the detonator cannot occur prior to the higher value of times Tp1 and Tp3.

Another operating mode of the device described above comprises authorizing firing of primer 13 via booby-trap module 200 upon expiration of the longer of delays Tp1 and Tp3, specifically during the entire programmed timing interval; and, if applicable, in inhibiting transistors 50 and 55 when the timing interval elapses, thus rendering the device inert and recoverable. The reaction time between actuation of the booby-trap system and firing of the

primer is, in this case, equal to Tp2.

According to a variant embodiment of the invention, the timing means can be simplified as depicted in Figure 5. The priming device then comprises an electrical power supply 310 (batteries in this instance), a timed-opening relay 330, a timed-closure relay 335, a capacitor 336, and a priming resistor 12 of primer 13.

As soon as the batteries are inserted, the two relays are energized. Since relay 330 is initially closed, the capacitor charges. The relay 330 opens after an interval Tp4, then relay 335 closes and capacitor 336 then discharges into resistor 12, causing firing of primer 13.

In the case of priming by displacement of a mechanical element, discharge of the capacitor supplies power to a solenoid, activation of which causes release of the electromechanical element which primes the detonator.

As far as the booby-trap means are concerned, accidental breakage of the tripwire, or opening of an inertial contactor when the priming device is moved, cause priming of the detonator. For safety reasons, however, priming cannot occur before the expiration of intrinsic safety time Tp1 and operational safety time Tp3, resulting from electromechanical means and/or timed switch 65.